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Title: Observing tropospheric water vapor by radio occultation using the Global Positioning System

Authors: E. R. Kursinski and G. A. Hajj

Radio occultations of Global Positioning System (GPS) satellites from low Earth orbit offer a new method of remotely observing tropospheric water vapor. The occultation geometry yields a unique combination of high vertical resolution (- 1 km or better) at long wavelengths (-20 cm) insensitive to particulate scattering allowing routine limb sounding from the mesosphere through the troposphere. A single orbiting receiver tracking both the GPS and the Russian GLONASS constellations of satellites would observe -1000 occultations per day distributed globally, providing as many profiles as the present global radiosonde network, but with far more even coverage.

Occultations yield profiles of refractivity as a function of height. In the cold, dry conditions of the upper troposphere and above (T<250K), profiles of density, pressure (geopotential), and temperature can be derived. Given additional temperature information, water vapor can be derived in the middle and lower troposphere. At low latitudes, profiles of water vapor derived from occultation observations should be accurate to better than 5% within the convective boundary layer and better than 2070 below 6 to 7 km [Kursinski et al., 1995]. The accuracy of derived mean humidity will be perhaps a factor of 3 better.

GPS occultation observations commenced with the launch of GPS/MET in April, 1995. We have derived water vapor from GPS/MET observations using temperatures from the nearest 6 hour ECMWF global analysis and made comparisons with ECMWF analyses, radiosondes and the humidity climatology of Peixoto and Oort which we will summarize. Of particular note are the signature of the tropical Hadley circulation and biases between ECMWF and occultation humidity fields apparently related to the Hadley circulation. Further, the atmosphere below the 500 mb level appears somewhat drier in general than the ECMWF humidity field.

Because of its unique and complementary features and high accuracy, several groups are developing methods of assimilating GPS data into weather models. Following the prototype GPS/MET receiver, four occultation receivers will launch over the next two years. Further a GPS receiver has been chosen as a sensor on both the next generation U.S. and European weather satellites so the technique appears to have a promising and expanding future. Ultimately a constellation of GPS receivers may be implemented in space in sufficient numbers to dramatically impact weather forecasting and climate research.

We will present an overview of the technique, its strengths and limitations and plans for the near and more distant future.

Reference: Kursinski et al., Observing tropospheric water vapor by radio occultation using GPS, GRL, 17, 2365-2368, 1995